SHOUT
SHARE
IT

Experiment Station Library.

Class 639.73

Number N53

Volume 4

Source Binding

Received February 1912

Cost 1.00

Accession No. 17648

Bulletin 136 February, 1908

NEW HAMPSHIRE

AGRICULTURAL EXPERIMENT STATION

The Gipsy and Brown Tail Moths

IN NEW HAMPSHIRE

By E. DWIGHT SANDERSON

(Printed by order of the Governor and Council)

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS.

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION,

DURHAM, N. H.

BOARD OF CONTROL.

Hon. JOHN G. TALLANT, *Chairman,*	Pembroke
CHARLES W. STONE, A. M., *Secretary,*	East Andover
Hon. WARREN BROWN,	Hampton Falls
Hon. N. J. BACHELDER, A. M., M. S.	East Andover
Pres. WILLIAM D. GIBBS, ex officio,	Durham

THE STATION STAFF.

E. DWIGHT SANDERSON, B. S., B. S. A., *Director and Entomologist.*
FRED W. MORSE, M. S., *Vice-Director and Chemist.*
FREDERICK W. TAYLOR, B. Sc. (Agr.), *Agriculturist.*
HARRY F. HALL, B. S., *Horticulturist.*
CHARLES BROOKS, A. M., *Botanist.*
FRED RASMUSSEN, B. S. A., *Dairyman.*
WILLIAM H. PEW, B. Sc. (Agr.), *Animal Husbandman.*
BERT E. CURRY, M. S., *Associate Chemist.*
JASPER F. EASTMAN, B. S., *Assistant Agriculturist.*
CHARLES S. SPOONER, A. B., *Assistant Entomologist.*
JOHN CLYDE WILCOX, B. S., *Assistant Horticulturist.*
GEORGE S. HAM, *Farm Foreman.*
DAVID LUMSDEN, *Foreman of Gardens and Greenhouse.*
NELLIE F. WHITEHEAD, *Purchasing Agent.*
MABEL H. MEHAFFEY, *Stenographer.*
MABEL E. TOWNSEND, A. B., *Librarian.*
LAVINIA BROWN, *Assistant Bookkeeper.*

His Excellency, Charles M. Floyd,

Governor of New Hampshire.

Sir:

Agreeable to a resolution of the governor and council, I have the honor to submit the manuscript of a bulletin upon the Gipsy and Brown-tail Moths in New Hampshire, to be published as Bulletin 136 of this station.

I am indebted to Mr. George E. Merrill of Hampton Falls, N. H., for the account of the work against the gipsy moth during the summer and early fall of 1907 and the present conditions in the coast towns; and to Dr. L. O. Howard, chief of the Bureau of Entomology, U. S. Department of Agriculture, through whose courtesy Mr. D. M. Rogers, in charge of the gipsy moth work, has furnished me with the record of the infestations found by their scouts up to date.

Yours very respectfully,

E. Dwight Sanderson, *Director.*

New Hampshire Agricultural Experiment Station,
Durham, New Hampshire.

January 23, 1908.

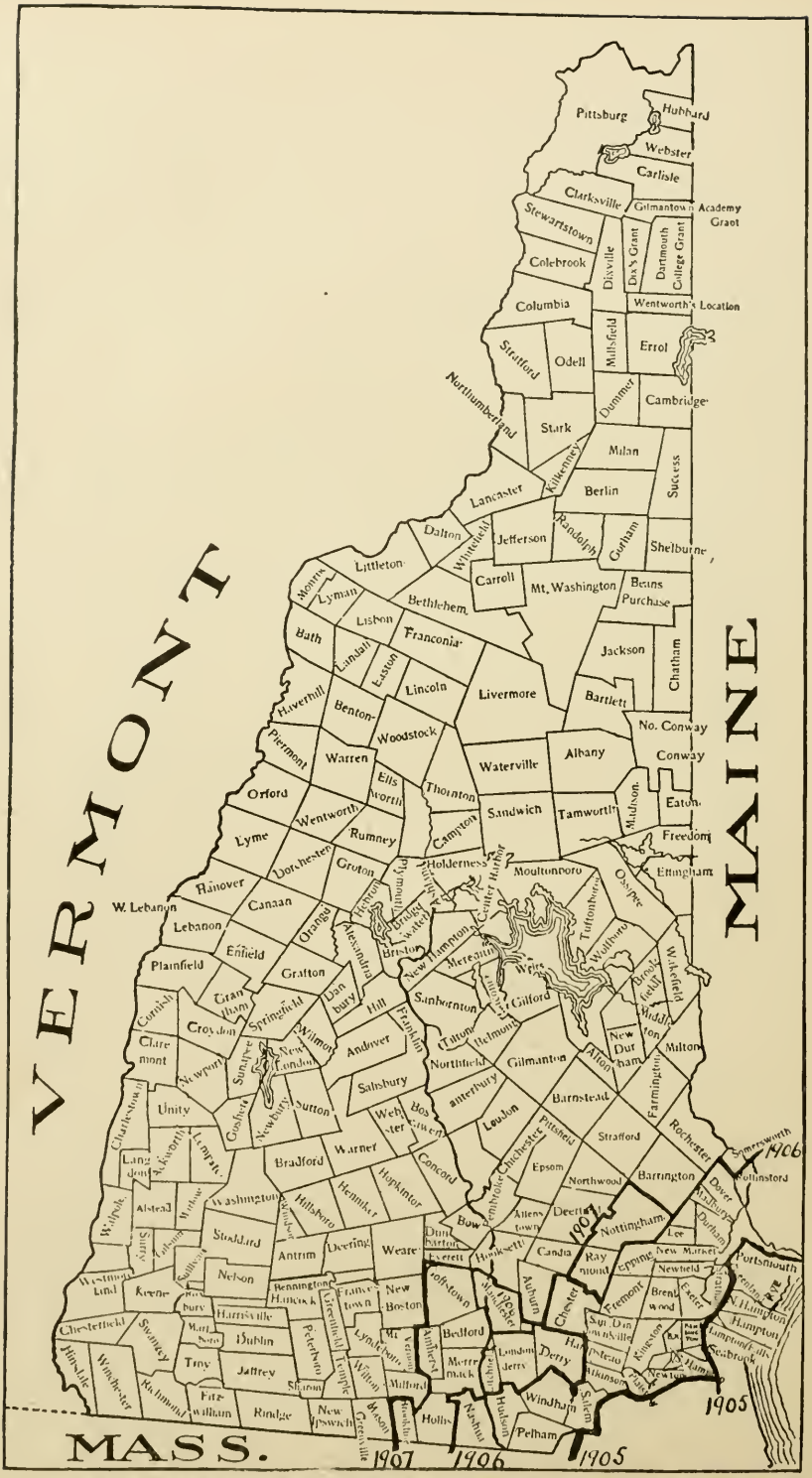


FIG. 1.—Map showing the gradual spread and present distribution of the gipsy moth in New Hampshire.

THE GIPSY MOTH.

HISTORY.

The gipsy moth has been known as a serious insect pest in Europe from the time of the earliest naturalists, the first authentic record being in 1662. It extends throughout the continent of Europe, over much of Asia and into Northern Africa, but is chiefly injurious in Central and Eastern Europe. It frequently does serious injury there by defoliating large areas of forest and more frequently fruit and shade trees, but its ravages cease in two or three seasons, not to occur again for several years, like those of many of our native insects, such as the Forest Tent Caterpillar and Tussock moth. In 1868 the insect was brought to this country by Prof. Leopold Trouvelot at Medford, Mass., in his experiments in silk producing. Escaping from him into the neighboring woodland, the insect increased gradually for several years before noticed, but in 1890 had become such a serious pest throughout this and neighboring towns that the state of Massachusetts commenced the arduous task of its extermination. In 1890 the insect had invaded some twenty towns, from Cambridge on the south to Lexington on the west, and Reading and Beverly on the north. This work was ably carried on by the Gipsy Moth Commission and the Massachusetts Board of Agriculture, who annually employed a small army of men in the fight, and who expended up to 1900 approximately a million and a quarter of dollars. As a result, so few of the moths could be found in 1899 and so little damage was caused by the insect, that the legislature of 1900, probably not realizing the necessity of continuing control measures, stopped the work. Had a small annual appropriation been made and continued at this time, the future spread would undoubtedly have been prevented and the control of the insect become more and more effectual, though utter extermination

might never have been possible. However, in 1898, "in seven of the formerly infested towns no gipsy moths were found. In five others but one to three small spots were found infested, and in these no eggs were found in the fall inspection; in the other outer towns comparatively few moths were found." (Forbush.) In 1898 the insect had spread to but three towns outside those infested in 1890, when the work began. The possibility of the practical control of the pest was, therefore, thoroughly established.

From 1900 to 1904 the only effort toward control was by local towns and private parties, with but partial success, owing to the lack of concerted action. In 1904 the moth had increased so enormously that it became evident that state aid was again necessary for its control, and the Massachusetts legislature of 1905 made an appropriation of $150,000 per annum for aiding the towns in the work. Under this act, a state superintendent appointed by the governor has general oversight of all the work. Upon passage of the act, Mr. A. H. Kirkland, formerly assistant entomologist of the Gipsy Moth Commission and one of the foremost economic entomologists of the country, was appointed superintendent, and in 1906 the legislature showed their confidence in his work by increasing the appropriation to $225,000 per annum. Inspections made by his scouts in 1905 showed that the moth had spread to 120 towns, west to Concord, Chelmsford and Sherborn, Mass., and southeast to Plymouth, Mass., extending over four times the area previously infested.

At the present time the gipsy moth occurs in Massachusetts along the New Hampshire line from Salisbury west to Ashby, which is opposite Mason and New Ipswich, or to the western boundary of Hillsborough County, N. H.

In Other New England States.

RHODE ISLAND.

Mr. A. E. Stene, superintendent of the gipsy moth work for Rhode Island, writes: "The territory infested with

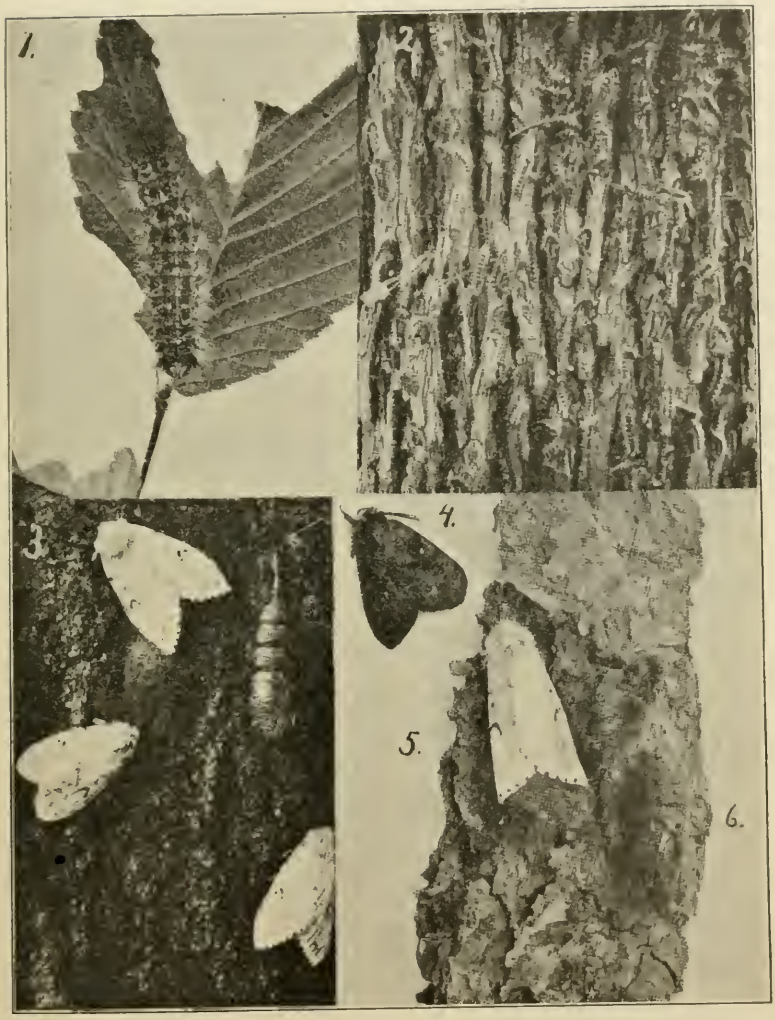


FIG. 2.—1, Gipsy Moth caterpiliar feeding on elm leaf; 2, Gipsy Moth caterpillars clustered on elm trunk; 3 and 5, female Gipsy Moths laying eggs (reduced); 4, male Gipsy moth; 6, pupa case from which moth has emerged. (After Kirkland).

the gipsy moth in this state is approximately twenty-five miles square and embraces nearly all of Providence and a little of the following towns, which border on the city of Providence: Cranston, Johnston, North Providence, Pawtucket and East Providence. During the past year's work a few new infestations have been found, but there is an equal if not greater number of places that were infested last year in which we have found no trace of the insect since the burlap work began last spring. In all places the insects have been very greatly reduced in numbers. In the city districts the average number of nests for any one infestation is not over ten or twelve and the total number of nests for the year will probably not amount to one twenty-fifth of what was found last year. During the past summer there were no trees defoliated and very few on which the caterpillars were numerous enough so that a casual observer would have noticed their work on the foliage. We feel very much encouraged with the results of the work so far and we hope the state will give us sufficient appropriation so that we can follow out a policy of extermination before the moth has a chance to spread into the woodlands of the state."

The conditions in Rhode Island are therefore exceedingly encouraging, inasmuch as serious damage was done in Providence in 1904 and 1905.

MAINE.

Prof. E. F. Hitchings, state entomologist of Maine, writes: "We have at present about fifty men engaged in the work of destroying the egg clusters of the gipsy moth, cleaning up the trees and underbrush in the new-infested sections of York County. This work at present is mostly confined to the towns of Kittery, Elliott and York. Over six thousand clusters have been destroyed up to date and new ones are being added each day."

The infested towns and number of infestations in each are as follows: Eliot, 79; Kittery, 172; Berwick, 3; South

Berwick, 3; Kennebunkport, 2; York, 78; Wells, 18; North Berwick, 9; Sanford, 1; Kennebunk, 4; and National Reservation at Togus, 1.

CONNECTICUT.

Dr. W. E. Britton, state entomologist of Connecticut, writes: "The gipsy moth in Connecticut occupies an area of less than one square mile, which is practically the same as given in my last report. We have found a few caterpillars a short distance toward the west, and have contracted the boundary line somewhat on the east, but there is really no spread, and no further infestations have been discovered in spite of careful scouting work which has been done by the state men and by the United States inspectors.

The insect is well under control, though not yet exterminated. I have men there now at work, and while they will continue through the winter, clearing up brush and rubbish and pruning trees, they have nearly finished the scouting work, and have destroyed something like one hundred and twenty egg masses since the eggs were laid in August. It hardly seems probable that they can find many more, so thorough has their examination been."

History of Spread in New Hampshire.

Realizing the probability of the spread of the gipsy moth into New Hampshire by the large amount of automobile traffic along the main road from Newburyport, Mass., to Portsmouth, N. H., in December, 1904, the writer had the trees along it examined through the towns of Seabrook and Hampton Falls by two trained assistants. No traces of infestation, however, were found at this time.

In September, 1905, the inspectors of Massachusetts had located the pest in all of the towns along the northern boundary of Massachusetts from Methuen eastward, and discovered that it had existed in Newburyport since 1904. It was, therefore, apparent that the neighboring towns of New Hampshire were undoubtedly infested. Through the courtesy of the Massachusetts superintendent for suppress-

ing the gipsy moth, Mr. A. H. Kirkland, we secured the services of one of the most experienced of the Massachusetts inspectors, who, in company with our assistant, Mr. W. P. Flint, inspected all the towns along the coast from the Massachusetts line to and including the city of Portsmouth. The pest was found in all of these towns, though only the main road and the village streets were examined, except in Portsmouth, where practically the whole city was inspected. But a small portion of each town was, therefore, examined, merely enough being inspected to establish the existence of the pest and something as to its relative abundance. One or two examinations of back roads, not so much traveled as the main road, revealed, however, the presence of eggs along them. In two of these infestations the pest had been introduced in 1904, from 25 to 30 egg masses were found this year, and the caterpillars had spread from the original point to nearby orchards, 200 yards distant. The number of infestations found and their nature were as follows:

INFESTATIONS IN 1905.

Town.	Number of localities infested.	Number new egg masses.	Number old egg masses.
Seabrook	14	21	..
Hampton Falls	6	8	..
Hampton	14	17	..
North Hampton	5	30	1
Greenland	1	..	..
Rye	7	35	1
Portsmouth	2	..	..
Total, 7.	49	114	2

The cities of Exeter and Nashua were also carefully examined but no trace of the gipsy moth found.

1906. In the spring of 1906 Congress made an appropriation of $83,500 to the Secretary of Agriculture for pre-

venting the further spread of the gipsy moth. The appropriation did not become available until July 1 and early in August scouts were put at work in the infested towns in New Hampshire. Up to December, 1906, when Bulletin 128 of this station went to press, no other towns had been scouted in New Hampshire, but in January and February, 1907, some twenty-six towns were found infested by the scouts of the Bureau of Entomology, U. S. Department of Agriculture, under the direction of Mr. D. M. Rogers, with headquarters at Boston, and by June, 1907, the list had grown to thirty-three towns and three cities. The spread of the pest in 1906 is shown on the map, figure 1, and the list of infestations is given in the table below.

Although the limit of the infested territory had not been reached, scouting stopped in June, 1907, because the eggs had then hatched and the foliage of the trees prevented effective work in locating the egg masses. A somewhat superficial examination of the chief mountain and lake resorts was made during June, but no infestations were found north of Dover, nor farther west than Manchester and Nashua.

The number of infestations in the different towns varied from one each in Durham, Lee, Chester and Newington to eighty-five in Rye. The total number of infestations discovered during the inspection of the winter, 1906–'07, was 483 and the whole number of egg masses found and creosoted was about 4,000.

1907. By the time the legislature met in January, 1907, the scouting had revealed the seriousness of the infestation in New Hampshire, and Bulletin 128 of this station by Dr. L. O. Howard, entomologist of the U. S. Department of Agriculture, and the writer, pointed out the desirability of legislation patterned very closely after that found successful in Massachusetts. Governor Floyd in his inaugural message called attention to the seriousness of the pest and urged adequate legislation for its control. As a result, a bill following very closely the law of Massachusetts was

THE GIPSY MOTH.
FIG. 3.—1, Full-grown caterpillars; 2, Pupa; 3, Female laying eggs.
All life-size (after Kirkland).

drawn by Hon. Allen Hollis of Concord, and with minor amendments, the most important being the reduction of the appropriation from $50,000 per year for two years to $25,000 for two years, was finally passed and approved by the governor. The original draft of the bill contemplated placing the work in the hands of a state entomologist, as in Massachusetts and other states, but a separate bill introduced by Mr. Hollis creating that position, after passing the committee on agriculture of the House, was reported unfavorably by the committee on appropriations. The enforcement of the law was therefore left in the hands of the governor and council, with authority to appoint a state agent to have charge of the work if they deemed necessary.

Work in Summer of 1907. Under this law on May 22, 1907, Governor Floyd and council contracted with Munson and Whittaker, a Massachusetts firm of contractors for tree work, to do the necessary burlapping of trees in infested localities to catch the caterpillars, hatching from eggs which were not found by the scouts in their necessarily hasty inspection the previous winter. Work under this contract was begun immediately by seven crews of five or six men each, scattered throughout the infested territory, and by June 20 practically all the necessary burlap had been applied to the infested and neighboring trees. The work of the contractors was inspected for the governor and council by Mr. G. E. Merrill, of Hampton Falls, N. H., and who had been in charge of a party of scouts of the Bureau of Entomology and had been over the entire infested territory. No accurate record was kept of the trees banded, but Mr. Merrill estimates that about 36,000 trees were burlapped; in Hampton, 3,500; North Hampton, 4,000; Rye, 5,000; Portsmouth, 3,000; Hampton Falls, 2,000; Greenland, 2,000; Seabrook, 2,000, and the remainder of the infested district, 14,500. In the towns of Hampton, North Hampton, Rye and Portsmouth, where the worst infestations occurred, the bands were examined daily. In the other towns the burlaps were ex-

amined as often as possible when caterpillars were found, but if no caterpillars were found at the first two or three examinations, these burlaps were not examined for two or three weeks.

As the season was unusually late, the caterpillars had not acquired the night-feeding habit by the time the burlaps had been applied, June 20, so that labor in examining the bands at this time would have been wasted. Accordingly the state inspector employed the contractor's men for two weeks in pruning, scraping and sealing the holes in the trees of the badly infested orchards. Some roadside cutting was also done in Hampton and North Hampton. During this time twenty-nine of the worst colonies were wholly or partly cleaned.

Beginning July 5, the burlaps were examined as often as possible for the caterpillars of the gipsy moth and in 171 of the 495 infested localities caterpillars were secured, the number destroyed in each case varying from many thousand in the larger colonies in Rye to less than twenty-five in many of the minor infestations. This work stopped August 7. Although some instances of negligence on the part of some of the contractor's men have recently come to light, their work was as satisfactory on the whole as was expected under the conditions. As the work of scraping and pruning and sealing the holes in the trees was wholly neglected except for the comparatively few places cleaned during June, a large part of the burlapping was not as effective as it would have been had such cleaning up been done in the spring.

During November, 1907, two crews of men were placed at work in Dover and North Hampton, cleaning trees in infested spots, and similar work is now going on. At this time the work was in charge of Mr. George E. Merrill, to whom I am indebted for furnishing most of the data concerning the work during the year 1907. Mr. Merrill outlined his policy for the work of the winter, as follows: "As the amount of money at the disposal of the agent is wholly

FIG. 4.—Egg masses on neglected apple tree, Arlington, Mass., March, 1905.

inadequate for the fighting of the moth according to the methods at present most approved in Massachusetts, it seems best to work on the following lines and this is what is now being done.

"First, to clean up the worst colonies in the badly infested coast towns in order to prevent them becoming notable centers of distribution within a few years.

"Second, to clean up all the bad colonies near the border of the infested territory, to prevent as far as possible the spread of the moths into thickly wooded and sparsely populated sections of the state."

On December 6, 1907, Col. Thomas H. Dearborn of Dover was appointed state agent for suppressing the gipsy and brown-tail moths and has since that time prosecuted the work along the lines above outlined.

Present Condition in New Hampshire.

The conditions in the most badly infested towns, as reported by Mr. Merrill, are briefly as follows:

SEABROOK.

This town was scouted early in the fall of 1906 while the foliage was still on the trees, and it is extremely probable that many infestations were missed. It is also highly probable that much of the woodland in the southern portion of the town is infested, as Seabrook is nearer than any other New Hampshire town to the worst district in Massachusetts. The true condition of the town, like the others in this vicinity, will not be known till the government has thoroughly scouted it.

HAMPTON FALLS.

Hampton Falls should be in a better condition than its neighbors, as it is the only town in the state that has independently fought the gipsy moth. During the spring of 1907 two experienced men were employed by the town to examine carefully all suspected localities and find and destroy all egg clusters of the gipsy moth. As the work of the government scouts during the preceding fall had been done quickly and when the leaves were on the trees, these men employed by the town had no difficulty in locating and treating several new colonies.

The worst colony thus far discovered in the state is located at Healey's Island in Hampton Falls and was brought to the attention of the state inspector about September 1. Healey's Island is a scrub oak island in the marsh, about two acres in extent, and is used by the farmers of this region as a base for conducting their salt marsh haying operations. From this it is evident that unless this colony is decisively dealt with during this winter it will become a notable center of distribution during next summer.

HAMPTON.

Although no very large colonies are known at present to exist in Hampton, orchards east of the Boston and Maine Railroad are generally infested and should be closely watched during the next few years.

NORTH HAMPTON.

North Hampton in 1906 contained the largest colony which at that date had been discovered in the state. This colony was situated in apple orchards located on Chapel Road near Little Boar's Head. In fact nearly all the orchards in this vicinity were infested. Since its discovery vigorous measures have been taken against this colony, and should the fight continue the colony will be exterminated during the next two years.

RYE.

Rye is apparently the most badly infested town in the state. The orchards containing the worst colonies have been thoroughly cleaned, and with continuous care should in a few years be free from the pest. There are, however, many orchards and a few street trees which should be given attention during the present winter.

PORTSMOUTH.

Portsmouth is quite generally infested, the worst colony being found in two rows of willows on the Lang Road. These willows should be cut and burned as soon as possible.

The following summary by Mr. D. M. Rogers, gives the conditions in towns examined during the winter 1907–08, up to Feb. 1, 1908.

DOVER.

The inspection of Dover this winter revealed no serious infestations, eight being the largest number of egg-clusters found in any one place. In the majority of cases a single egg-cluster was found.

DURHAM.

In Durham only a single egg-cluster was destroyed at each of about a dozen infestations, and at only one place was there more than one found.

EPPING.

In Epping the gipsy moth is scattered pretty thoroughly over the town. In several places ten or twelve egg-clusters were taken, although the majority of infestations were of single egg-clusters. The State, in conjunction with such aid as the Federal Government is able to furnish, is at present engaged in pruning, tin-patching and clearing up the most seriously affected places. Why this town has become more seriously infested than its neighbors is at present uncertain, but a careful scout of suspicious woodlands in this vicinity will be made during the spring or early summer.

HUDSON.

In Hudson there are 16 infested estates, 10 of which show only a single egg-cluster, while in one estate on Gumpus Hill Road about 100 egg-clusters were taken, which is the worst infested place we have found in New Hampshire so far this winter. Aside from this place, and one or two others, there should be little difficulty in handling. At the bad places strenuous measures should be adopted.

LEE.

In Lee 19 egg-clusters were destroyed on nine estates. In six of these places a single egg-cluster only was found.

MADBURY.

The examination of Madbury resulted in discovery of the gipsy moth on seven estates with a total of eight egg-clusters.

MANCHESTER.

In Manchester a majority of the infested places showed a single egg-cluster, but in two places more serious colonies were found. At one place 20 egg-clusters were destroyed, and at another 14. In several cases in Manchester the gipsy moth occurs on the street trees. These should have more careful attention, because of the possibility of distribution by vehicles passing through these streets to the outlying country.

NASHUA.

This city presents quite a serious gipsy moth problem, it being a center for considerable travel to neighboring towns. One hundred and thirty-two egg-clusters were taken; in many cases only a single one, but in six localities larger colonies were found varying from 10 to 25 egg-clusters. Unless these places are thoroughly cleaned up, we may have reason to expect future trouble in this locality.

ROLLINSFORD.

A year ago this town was infested, a single egg-cluster being found. A careful search this year throughout the town failed to reveal the presence of the gipsy moth.

SANDOWN.

Sandown, which was infested a year ago, shows considerable increase in the moth, although so far we have not found any particularly bad colonies. Our foreman there has noted the presence of the gipsy moth along the edge of woodland. Later in the season when woodland scouting is taken up a more thorough examination will be made here.

WINDHAM.

Windham, which was infested last year, shows something of an increase, but the town has not been finished as yet. Considerable additional work will be needed there.

BEDFORD.

In Bedford six estates were found infested, each with a single egg-cluster of the moth, distributed along the main line of travel following the course of the Merrimac river.

GOFFSTOWN.

Goffstown is only slightly infested, with no bad colonies known, but should be carefully watched.

LONDONDERRY.

Londonderry, in which the presence of the moth was not known last year, yielded 71 egg-clusters, a majority of these being single ones, although there are two or three bad places. In one 25 egg-clusters were destroyed.

MERRIMACK.

In Merrimack nine egg-clusters were taken on four estates. As in Bedford, these are distributed along the main route of travel following the Merrimac river.

NOTTINGHAM.

This town presents quite a serious problem, as it is isolated from the railroad and the gipsy moth is known to have appeared on 26 estates, 32 egg-clusters having been destroyed, in nearly every case only a single one, Active measures should be taken to prevent the spread of the moth north from this town. If the moth is allowed to spread into the more sparsely settled regions, where the value of the land is not so great as near large towns, it will soon get beyond the possibility of control.

RAYMOND.

In Raymond five egg-clusters were taken on four estates. While the town does not present a serious aspect at present, if active measures are not taken more serious trouble may be expected.

AMHERST.

The gipsy moth has been discovered in two places in the extreme western part of the town not far from the Mont Vernon line.

The following table gives a summary of the conditions in each of the infested towns:

TOWN.	To September 1, 1907.			To Feb. 18, 1908.
	Number of infestations found.	Number of places caterpillars found during burlap season.	Number of places cleaned.	Number of infestations.†
Amherst				3
Atkinson	11	5		†
‡Auburn				0
Bedford				7
Brentwood	6	4		
‡Candia				0
Chester	1	0		7
Derry				32
Dover	4	2	1	20
Durham	1	1		13
East Kingston	4	2		
Epping	3	1		76
Exeter	2	1		
Fremont				33
Goffstown				4
Greenland	27	21		
Hampstead	6	4	1	45
Hampton	61	55	3	
Hampton Falls	*41	38		4
Hollis				4
Hudson	3	2	2	15
Kensington	11	10		
Kingston	9	5		
Lee	1	1		9
Londonderry				24
Madbury	2	1		7
Manchester	2	0		17
Merrimack				4
Milford				2
Nashua	7	4	3	27
Newcastle	5	3	2	7
Newfields	2	1		
Newington	1	0		17
Newton	7	5		
North Hampton	40	40	2	
Nottingham				22
Pelham	20	13	13	
Plaistow	11	8	2	
Portsmouth	39	21	5	83
Raymond				4
Rollinsford	1	0		0
Rye	85	80	4	
Salem	30	15	4	
Sandown	4	1	1	19
Seabrook	25	16		
South Hampton	6	4		
Stratham	8	6		
Windham	5	0		38
	491	370	43	549

* Eleven new infestations discovered in Hampton Falls in spring of 1907 by men employed by the town.

† Towns not recorded have not been examined this winter.

‡ Examined—nothing found.

Life History.

Like all insects of its class, the gipsy moth passes through four different stages during its life history.

The Egg.—(Figure 4.) The eggs are laid in July and August, in a mass of 400 to 500, covered with yellowish hairs from the body of the female. The individual mass is of an irregular oval shape, one and one-half by three-fourths inches. as shown natural size in Figure 2, and is usually deposited on the bark of trees, but where abundant on fences, stones, buildings, etc.

Fig. 5.—Eggs of Rusty Tussock Moth. (*Notolophus antiqua* Linn.)

The eggs of two species of our common tussock moths might be readily mistaken for those of the gipsy by one unfamiliar with the latter. The eggs of the Rusty Tussock Moth (*Notolophus antiqua* Linn.), which is the more common species, except in southern New Hampshire, are usually laid on the leaves which remain attached to the tree and are laid in but a single layer with no protecting cover over them, so that each egg is distinguishable, as seen in Figure 4. The eggs of the common White-Marked Tussock Moth (*Hemerocampa leucostigma* S. & A.) which is common in southern New Hampshire and southward, often doing serious damage to shade trees in the cities of the Middle States, are covered with a white frothy substance and laid in a compact mass upon the trunk or limbs of a tree, and are not unlike the egg masses of the

gipsy moth. The mass of the tussock moth is pure white, while that of the gipsy is yellowish or dark creamy, from the hairs or scales from the body of the female, which cover it, which are entirely absent from the eggs of the tussock moth. The eggs of the tussock moth (see Figure 6, which illustrates the well-known tussock caterpillar) are usually laid on the cocoon from which the female emerged, while those of the gipsy moth are laid directly on the bark of the tree.

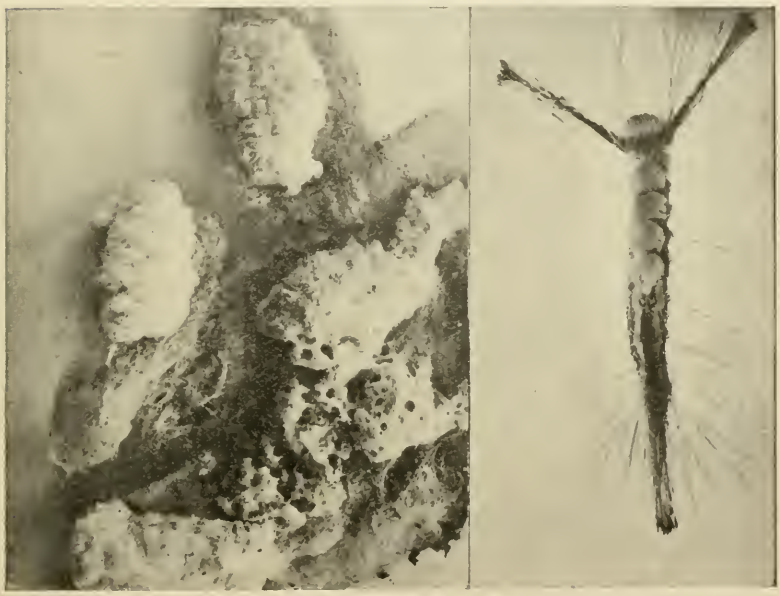


FIG. 6.—Eggs of White-Marked Tussock Moth on cocoons of females, and full-grown caterpillar, natural size.

The Caterpillar or Larva.—(Figure 3.) The eggs hatch about May 1 and each mass or "cluster" yields a swarm of young caterpillars, the bulk of which become full grown by midsummer. Gipsy moth caterpillars of any age are decidedly hairy. The mature caterpillar has a dusky or sooty-colored body. Along the back, counting from the head,

which is marked with yellow, is a double row of five pairs of blue spots, followed by a double row of six pairs of red spots. This double row of spots may almost invariably be seen very distinctly on the back of a caterpillar which has attained a length of one inch and a half or more. No other New England larva has this double row of blue and red spots along its back. The mature gipsy moth caterpillar not infrequently attains a length of three inches. The caterpillars become full grown during July, mostly about the first. Injury done by the pest is, therefore, largely confined to the months of May and June, being most serious as the caterpillars become grown.

FIG. 7.—Male and Female Gipsy Moths. Natural size. (After Forbush and Fernald.)

The Pupa.—When fully grown, usually in July, the caterpillar spins a few threads of silk as a supporting framework, casts its skin and changes into a pupa, or, as it is sometimes called, a chrysalis. The pupa is dark reddish or chocolate in color and very thinly sprinkled with light reddish hairs. Unfortunately, it resembles the pupæ of certain other moths found in Massachusetts (and New England), and cannot, unless by experts, be identified at a glance. The thinly sprinkled, light reddish hairs are, however, characteristic. The pupa stage lasts from ten days to

two weeks, during which time the insect is comparatively dormant, while the wonderful changes take place by which the tissues of the worm-like caterpillar are so transformed that from the apparently lifeless pupa, the winged adult moth emerges.

The Moth.—(Figure 7.) "From July 15 to August 15 the winged moths emerge from the pupæ, the date varying according to the season and the time of pupation. The male is brownish yellow, varying to greenish-brown in color, has a slender body and expands about one and one-half inches. It flies by day with a peculiar zig-zag flight.

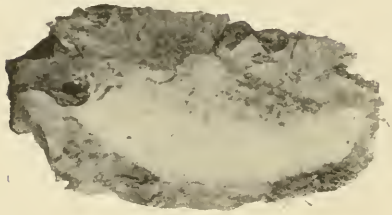
"The female moth is nearly white, with numerous small black markings, heavy-bodied and sluggish, and expands about two inches. The female does not fly, otherwise the spread of the gipsy moth would be most rapid. After mating the moths live but a short time. The female dies after depositing her egg mass (Figure 3.) The winged moths take no food. All damage to foliage is caused by the caterpillars."

The eggs remain over winter on the trees, as already described. Thus, there is but one brood or generation of the gipsy moth in a year, the different stages of which in their relation to each other are shown graphically in Figure 8.

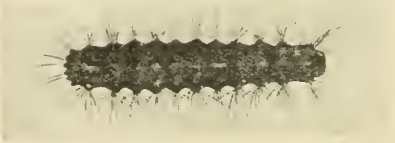
In view of the fact that the brown-tail moth has also recently been introduced into the state and that it is frequently confused with the gipsy moth, the following table may be of service in sharply distinguishing the two species, which are totally different in habits and require different methods of control:

THE STAGES AND LIVES OF THE GYPSY MOTH

Stages.	Gypsy Moth.
Egg Cluster	Usually on bark of tree; very rarely on leaf. Robust, 1½ to 2 inches long. Light yellow or creamy. From August to May.



Caterpillar. Full grown	Dark grayish or sooty. Double row of five pairs of blue, followed by six pairs of red spots along back.



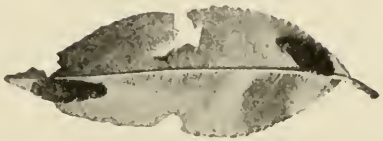
Moth. Female	Wings spread 2¼ in. Dingy-white, lightly streaked and blotched with blackish. No brush of brown hairs at tip of abdomen. Does not fly, crawls.

Winter Passed	In egg stage—see above. Never as a caterpillar.
Irritation of Human Skin	Not caused by any stage.

Most Effective Means of Control.

Soak eggs with creosote in fall, winter, or spring.

AND BROWN-TAIL MOTH CONTRASTED.

Brown-Tail Moth.	Stages.
Always on under side of leaf. Smaller and more slender. Dark or golden brown. July.	Egg Cluster. 
Bright tawny or orange. A conspicuous row of pure white spots or dashes along each side of body. Only two bright red spots on middle line at lower end of back.	Caterpillar.
Wings spread 1½ inches..... Pure snow white.	Moth, Female.
A conspicuous, sharply contrasted, thick tuft or patch of golden or brownish hairs at tip of abdomen. A swift, strong flyer, by night, and attracted to lights.	
As small caterpillars in a silken web or nest on tips of twigs, from which they crawl out in spring.	Winter Passed.

Irritation.

Hairs from caterpillars, which are often transferred to cocoons and moths, cause an annoying and painful irritation of the skin.

Most Effective Means of Control.

Cut off and burn webs in winter

MEANS OF DISTRIBUTION.

"The gipsy moth spreads chiefly during the caterpillar stage. While the caterpillars do not crawl very far from where they hatch, except when there is a scarcity of food, they have the habit, when small and young, of spinning

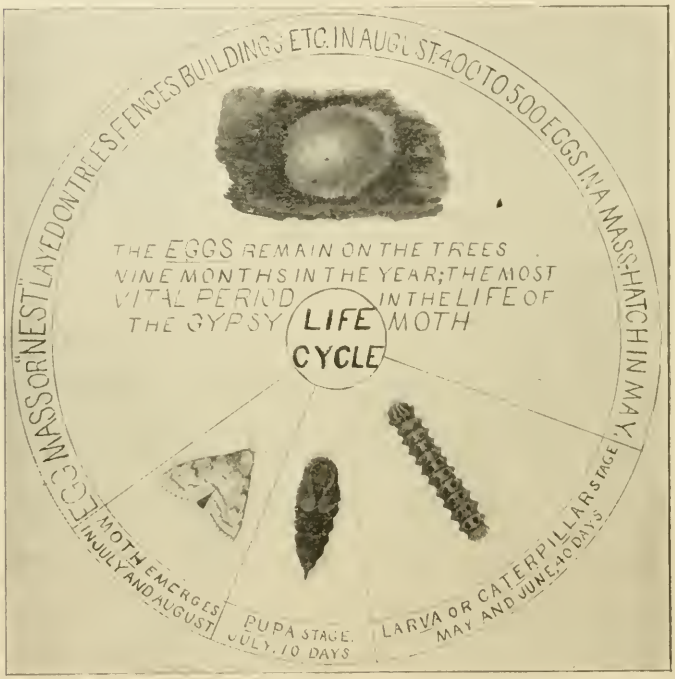

"MASS OR NEST" LAYED ON TREES, FENCES, BUILDINGS ETC. IN AUGUST 400 TO 500 EGGS IN A MASS. HATCH IN MAY
THE EGGS REMAIN ON THE TREES NINE MONTHS IN THE YEAR; THE MOST VITAL PERIOD IN THE LIFE OF THE GYPSY MOTH
LIFE CYCLE
MOTH EMERGES IN JULY AND AUGUST
PUPA STAGE. JULY. 10 DAYS
LARVA OR CATERPILLAR STAGE. MAY AND JUNE. 40 DAYS

FIG. 8.—The Life Cycle of the Gipsy Moth.

down on their silken threads from trees (as do the canker worm caterpillars in orchards), and, falling on vehicles, are then carried from place to place. Electric cars, pleasure and business vehicles, bicycles and automobiles are common means of thus transporting the gipsy moth.

"The special attention of all those upon whom gipsy moth suppression devolves is, therefore, directed to the necessity of keeping traveled highways free from the insect.

The caterpillars often crawl upon vehicles standing in an infested spot and by this means, also, are carried from one place to another."*

The writer has no doubt that many of the infestations of gipsy moth in New Hampshire have been introduced by automobiles, as they are practically the only vehicles, other than railroad cars, coming directly from the badly infested region of Massachusetts, and the infestations are found along the main roads and not near the railroads. Indeed, one case has come to our attention in which the owner of an automobile coming from Malden, Mass., removed a half dozen caterpillars from his machine upon arriving at Greenland, N. H., which were believed to be, and doubtless were, those of the gipsy moth.

"The egg clusters of the gipsy moth may also be transported on any of the numerous objects on which they are laid. Freight cars that have stood near the infested foliage for a period long enough for the laying of gipsy moth eggs upon them may even transport the pest." It is surprising, however, that as yet no instances have become known in which freight cars have carried the eggs, so that a colony of the moth has arisen at any distance from the badly infested regions, though certainly abundant opportunity must have arisen in past years.

From a careful study of the localities in New Hampshire infested with but a single egg mass and sufficiently distant from any small colony so that it seems improbable that the caterpillars might have been transported from any local infestation, it seems probable that the pest is being distributed and is spreading in some manner which has either not been observed or to which sufficient importance has not been attached. For instance, it seems strange that if the caterpillars are being transported mainly by vehicles that the egg masses are found fully as often on trees one or two hun-

* From Bulletin 1, Office of Superintendent, for Suppressing the Gipsy and Brown-Tail Moths, of Massachusetts, by A. H. Kirkland, from which are all other quotations, unless otherwise indicated, and to which we are indebted for much of the present article not directly quoted.

Fig. 9.—A piece of woodland at Arlington, Mass., typical of many, killed by defoliation by the Gipsy Moth caterpillars in 1904. Taken March, 1905.

dred feet back from the road as on those along the roadside. This matter will probably be given the careful study of an expert during the coming season, as it is a matter of the most vital importance in the future control of the pest.

FOOD PLANTS AND INJURY CAUSED.

"The gipsy moth caterpillar will attack all fruit, shade and woodland trees. It shows a preference for the apple, white oak, red oak, willow and elm. It will devour on occasion nearly every useful grass, plant, flower, shrub, vine, bush, garden or field crop that grows in Massachusetts (or New Hampshire).

"The caterpillar kills both deciduous (or hard-wood) and coniferous (soft-wood or evergreen) trees. Woodlands assailed by it in formidable numbers are stripped bare, as in winter, and many trees are killed. While several consecutive strippings are usually necessary to cause the death of a healthy deciduous tree, one thorough stripping will kill the white pine and other coniferous trees." Figure 9 shows the effect of a single stripping upon pine and spruce at Arlington, Mass., in 1904, the photo being taken by the writer in March, 1905. These trees were totally dead and fit only for firewood. Throughout acres of woodland in the worst infested district in Massachusetts, the pines, spruces and hemlocks have been almost entirely destroyed and the piles of cordwood attest the devastation wrought by the gipsy moth caterpillar. "Where the gipsy moth abounds in residence districts, it not only eats nearly everything green, but it swarms, in caterpillar form, upon houses, walks and verandas and often enters dwellings. In residential districts most heavily infested by the moth, real estate tends to rapid depreciation, so that it sometimes becomes a matter of difficulty to rent or sell property." Such instances now exist, as shown to the writer.

NATURAL ENEMIES.

"While the gipsy moth is a serious enemy of trees, it has its own foes in the shape of predaceous insects, para-

sites and birds. Several ground beetles prey on the caterpillars, while true parasitic insects attack both larvæ and pupæ. Several species of birds, notably vireos and cuckoos, consume large numbers of the caterpillars, while others, like the chewink, chickadee, blue jay and crow, do their part in reducing the numbers of the pest. The service of these natural tree protectors is worthy of high praise, but in attempting to control the moth the main reliance must be placed on human efforts—on the timely and thorough application of the remedial measures outlined'' below. As yet the native enemies have not shown ability to materially check the increase of the pest.

It is well known that in Europe the insect seems to be largely controlled by its natural enemies, so that serious outbreaks occur but once in a number of years in any one locality, in the same manner as do outbreaks of our native insects, such as the forest tent caterpillar or white-marked tussock moth, which are controlled by native parasites. A determined effort is, therefore, now being made by the Massachusetts superintendent, in coöperation with the Bureau of Entomology of the United States Department of Agriculture, in importing those parasites and predaceous insects which prey upon the gipsy moth in Europe. Already immense numbers have been imported from all parts of Europe and are being carefully reared in strict confinement at Melrose, Mass. It is the hope of everyone that these importations may result, within a few years, in such an increase of these enemies that they will be able to control the gipsy moth. It is the belief of the writer that ultimately either imported or native enemies of the gipsy moth will control it, as they do our native insects; but Nature works slowly, and whether such a condition will arise in five, ten or one hundred years, it is impossible to predict, as we have no experience with imported pests of a nature sufficiently similar to furnish us any precedent for comparison. Obviously, therefore, it will be folly to place any dependence upon these natural enemies until their value and ability to

even partially control the gipsy moth is clearly established, for meantime, if not controlled by the means already well known and which have been found effective, a condition might arise which would make it impossible to cope with the pest and we would be left comparatively helpless in attempting to control it in woodlands and forests.

An account of the work thus far done in importing these parasites will be found in an article by Dr. L. O. Howard, chief of the Bureau of Entomolgy in the Yearbook of the Department of Agriculture for 1905, pages 123–138, and more recently in the Second and Third Annual Reports of

FIG. 10—Killing the eggs of the Gipsy Moth in woodland, showing the large amount of labor and expense involved in combating the pest in badly infested districts. (After Forbush and Fernald.)

the Superintendent for Suppressing the Gipsy and Brown-tail Moths in Massachusetts.

REMEDIES.

Killing the Eggs.—"No single method of destruction against the gipsy moth is more effective than killing the eggs. The egg masses, wherever accessible, can be killed from August to May by soaking them thoroughly with creo-

sote mixture. The creosote may be applied with a small swab or paint brush. In killing gipsy moth eggs in high trees. it is usually best to work with two men; one man to point out the egg clusters from the ground, another to kill the eggs in the trees. (Figure 10). Creosote mixture may be purchased at agricultural warehouses and seed stores at from 50 cents to $1 per gallon, depending on the quantity."

CATERPILLAR DESTRUCTION.

Spraying.—"Spraying with arsenate of lead at the rate of 10 pounds to 100 gallons of water is very effective when the caterpillars are small. Any of the common hand outfits will suffice for the spraying of shrubs or flowering plants, but for use on trees a barrel pump is desirable. The poison should be thoroughly mixed in water and applied, if possible, on a clear day, in such a manner as to cover the leaves rather slowly with a fine mist. Spraying should begin at the top of the trees. The work is most effective when done during May and early June." Where orchards are to be sprayed, this spraying may be combined with that which should always be given for the codling moth and diseases.

Recent experiments in Massachusetts have shown that woodlands can be more cheaply sprayed by using a power outfit with a large hose and straight jet nozzle shooting a large stream into the air high above the trees, which descends upon them in a spray. This does away with the expensive climbing and makes the work much quicker. More materials are used but the cost of the work can be reduced to about $25.00 an acre.

Burlapping.—When a loose band of burlap or other cloth is tied about an infested tree trunk the caterpillars will gather under it in the day and may be destroyed by hand. The burlaps should be examined daily. But if there be numerous hollow stubs and loose bark on the tree, the caterpillars will secrete themselves there rather than under the burlap, so that to make the burlap treatment effective the trees should be thoroughly scraped and the holes plugged

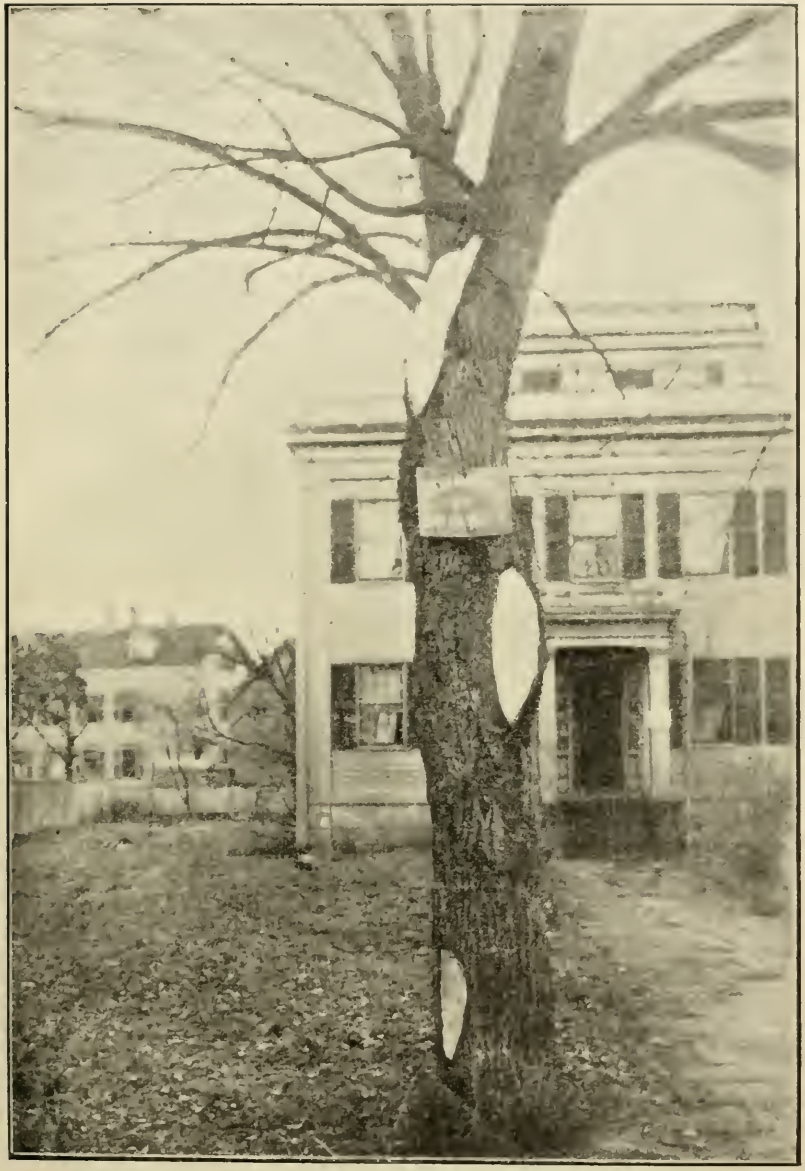


FIG. 11.—The breaking off of branches or bad pruning is responsible for hollow trees. In order to prevent these hollows from becoming the hiding places of the gipsy moth it is necessary to close them up with zinc patches as shown in this illustration. (After Stene).

or sealed during the winter. This burlap band is in no sense a tree protector. Its function is simply to give the shelter which the caterpillars seek by day. Unless carefully attended the burlap band does about as much harm as good. All burlaps should be applied early in June and should be removed at the end of the season.

Sticky Bands.—Where trees have been cleaned of the eggs, but it seems probable that they may become reinfested by caterpillars crawling to them from nearby trees, it is well to place a sticky band around the tree below the burlap band, thus preventing the ascent of caterpillars. A band of cotton with a strip of paper over it, upon which is smeared a broad thick band of printers' ink may be used, but the ink should not be applied immediately to the bark of the tree or injury may result. During the past few seasons large quantities of "tanglefoot" have been successfully used for this purpose with apparently no injury to the trees.

FIG. 12—An apple tree showing how errors in pruning have resulted in large holes in the trunk and branches of the tree. These have been closed up with zinc patches, to prevent the Gipsy Moth caterpillars hiding and Moths from laying in them. Tree about two feet in diameter. (After Stone.)

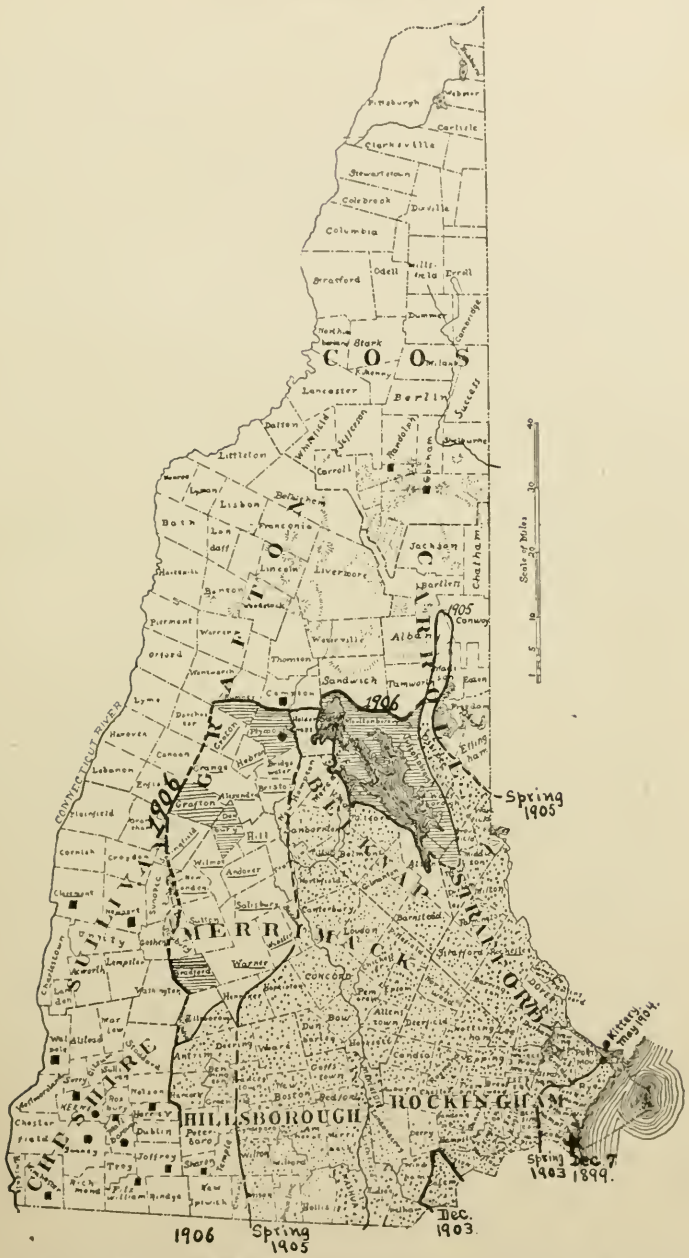


FIG. 13.—Map showing the gradual spread and distribution of the Brown-tail Moth in New Hampshire. Dotted area infested in 1906. Heavy lines are outer boundaries of areas infested in years indicated at margin. Dash lines represent approximate boundaries not personally investigated, based on points infested north of them. Black circles show points examined in January, 1906, and found uninfested. Black squares show points examined in December, 1906, and found uninfested. Towns shaded with horizontal lines found infested in December, 1906, and those underlined within 1906 boundary are undoubtedly infested, though not personally examined.

THE BROWN-TAIL MOTH.[1]

HISTORY.

The brown-tail moth was probably introduced into this country at Somerville, Mass., on nursery stock imported from Europe about 1890. Not until 1897 did it attract the attention of the Massachusetts Gipsy Moth Commission, whose agents thoroughly investigated the pest. No funds were then available for controlling it, though the Legislature passed a law "requiring the local authorities to suppress the brown-tail moths," and the Massachusetts Board of Agriculture determined its spread. In 1898 the work of controlling this insect was placed in the hands of the Massachusetts State Board of Agriculture, with $10,000 of the funds appropriated for the gipsy moth available for such work. Since that time the control has been in the hands of the local authorities.

In Europe this is one of the oldest and best known of the caterpillar pests, being called the "common caterpillar." It has been known there since the times of the earliest writers upon insects and natural history, excellent accounts of it having been written nearly three centuries ago. It is common over Central and Southern Europe, Western Asia and Northern Africa, and extends north into Sweden.

SPREAD AND DISTRIBUTION.

Occurring over a dozen towns when first recognized in 1897 and there being at no time a well-organized effort having sufficient funds for its control, the pest spread rapidly and in December, 1899, the first of its winter nests was found in New Hampshire, at Seabrook. Its spread since that time is approximately shown on the map, figure 13. Portsmouth and the coast towns became infested in 1901 and 1902 and in the spring of 1903 they were

[1] Euproctis chrysorrhœa L.

found to comprise the infested area in New Hampshire, with the exception of the southern part of Stratham. In December, 1903, no nests were found in Atkinson, and but few in Salem, N. H., along the Massachusetts line, they becoming scarce and disappearing northward in Salem, thus showing that the pest had not spread much over the line west of the eastern part of Rockingham County. The greatest spread occurred in 1904 during the summer flight of the moths in July. On Saturday, July 9, the moths invaded Nashua in immense swarms, so that the electric light posts and wires were white with them and they were reported in large numbers on all the principal streets by the police. At Newmarket they appeared on July 12, "by the million," according to Mr. Pinkham of *The Advertiser,* who stated that two quarts of the dead moths were taken from one arc-light globe and the front of a church was covered as if by a snowfall. On July 22 but few moths were to be seen in Newmarket. Further north the moths do not seem to have appeared in such numbers, though Manchester, Concord and Rochester became well infested. The spread in 1904 was the greatest recorded, the northernmost infested points being North Conway and Holderness, representing a spread of some seventy-five miles in that season, undoubtedly occurring during the flight of the moths. The exact spread in the southwestern part of the state was not determined as definitely as was desired, but there seemed to be but little infestation west of Concord. Inspections made by assistants of this office showed that Contoocook and Henniker were slightly infested, but Warner and Hillsborough were not. Specimens were received from several towns south and slightly east of these.

In February, 1904, this station issued a warning bulletin on the brown-tail moth by Dr. C. M. Weed, so that the public was well informed concerning it. In January, 1905, in coöperation with the state board of agriculture, a poster was circulated throughout the infested portions of the state, considerable attention was given the matter by the press,

granges, school teachers and others, so that everyone was awake to the necessity of controlling the pest by removing the winter webs. As a result the webs were very generally destroyed throughout the southern part of the state, this being aided with appropriations by many of the towns. To this effective work is undoubtedly due the fact that there was not more spread in 1905.

During July, 1906, the brown-tail moth continued to spread to the northwest into Grafton County, and north into Carroll County, but failed to spread westward into Cheshire County. Examinations made by an inspector of this station in November and December, 1906, show it to have spread over the area indicated in figure 13 in 1906. In those towns shaded the winter webs were found. The other towns within the boundary line connecting these towns were not examined but are undoubtedly infested.

No inspection has been made during the winter of 1907-'08 to determine the spread of the brown-tail moth during the past summer, so that the present distribution cannot be given. It has, however, been found in Fitzwilliam and occurs as far west as Winchendon, Mass., along the New Hampshire line. Towns in the southern part of the Connecticut Valley will do well to be on the constant lookout for the pest.

LIFE HISTORY.

The Winter Webs, or Nests.—During the winter the well-known webs of the brown-tail moth caterpillars are to be found on the tips of the twigs of fruit and shade trees. A typical example is shown in figure 14.

These webs are usually about three or four inches long, composed of leaves woven together with silk, which form a firm, tough web. The whole nest is often attached to the twig by the stems of the leaves, which have been worked into it, the stems being wound round and round with silk and this being continued onto the twig, as shown in the figure. If a nest be torn open it will be found to contain numerous little round, white, silky masses, looking like

spider's eggs, each of which contains two to a dozen small, brown, hairy caterpillars about one-sixth of an inch long (Fig. 15). At one side or lower end of the web is found a mass of black excreta and the cast skins of many of the

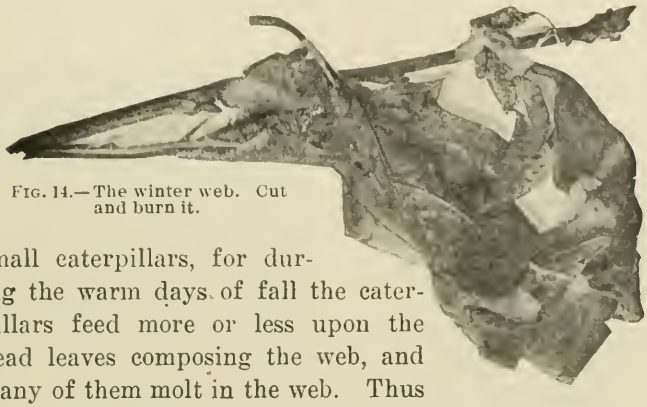


FIG. 14.—The winter web. Cut and burn it.

small caterpillars, for during the warm days of fall the caterpillars feed more or less upon the dead leaves composing the web, and many of them molt in the web. Thus the leaves of the web often become pretty well skeletonized.

There are no other webs common on trees which may be mistaken for these. Any webs containing small caterpillars

FIG. 15.—Winter web opened to show the different compartments or cells, each containing young caterpillars within.

in winter are those of the brown-tail moth. The tent-caterpillar and fall web-worm both make webs which often remain on the trees over winter, but they are weatherworn, thin webs, with no caterpillars, and are much larger. The curled elm leaves caused by the elm aphis often remain on

FIG. 16.—Old web of tent caterpillars.

FIG. 17.—Web of fall web-worm covering foliage. (After Weed.)

the trees over winter and may prove misleading to one whose eye is not trained to detecting the brown-tail webs. The eggs of the rusty tussock moth frequently found on fruit trees, especially plum, are often brought in for the eggs of the brown-tail where bounties are paid for its webs, but as the brown-tail's eggs are laid only in summer there should be no confusion.

With the warm days of late April and early May the little caterpillars emerge from their winter's home, the balance of which they often devour before going to the opening buds, upon which they feed greedily. The first emergence noted in Massachusetts was on March 18, 1898.

FIG. 18.—Elm leaf curled by aphis. (From Weed.)

FIG. 19.—Eggs of Rusty Tussock Moth.

the 29th of April being given as about the last of their appearance.

At Durham, N. H., the largest number of caterpillars emerged on May 6, 1905, April 29, 1906, and May 1, 1907, the whole time of emergence lasting for from a week before to a week or so after these dates.

Usually about 400 caterpillars emerge from a nest, though many of the smaller nests contain only 200 and a few nests on oak trees will contain 900 to 1,000. These large nests have usually been formed by the caterpillars hatching from several egg masses forming a common web.

Observations made during January and February, 1907, showed that where the temperature falls to below 25° below zero Fahrenheit, that large numbers of the caterpillars in the average size nests are killed and that where it drops to –35° Fahr. nearly all may be killed in average size nests, but that those in the large nests on the oaks of 700 to 900 caterpillars are not materially injured by these low temperatures.

FIG. 20.—Small Brown-Tail Moth caterpillars emerging from the winter web and feeding on the leaves of its surface.

Experiments have proven that there is almost no possibility of the caterpillars being caused to emerge in midwinter by several unusually warm days such as occurred January 21–23, 1906, at which time the newspapers surmised that the caterpillars would emerge and be killed by subsequent cold.

When they first emerge from the winter nest the young caterpillars are of a blackish color, covered with warm brown or reddish-brown hairs. The head is jet black, while the body is marked with yellow when seen under a lens. Projecting from the back of the fourth and fifth segments is a large tuft of reddish-brown hairs, looking

like a brush, and two thirds the height of the body. On the middle line of both the ninth and tenth segments is an orange or coral-red retractile tubercle. In about eight days the caterpillars shed their skins or molt, after which they are about two fifths of an inch long, the body hairs are relatively longer, though the tufts on the fourth and fifth segments are not so large. About the middle of May (15th to 20th), the second spring molt occurs. The caterpillar is now about three fifths of an inch long, the yellow markings of the body being more apparent, and the brown tufts on the back less prominent. In this stage the upper hairs of the tubercles along the sides of the abdominal segments are a distinct white color, forming a band of white dashes along either side of the caterpillar, which is so

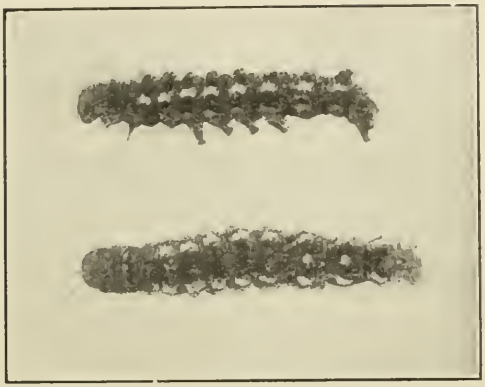


FIG. 21.—Full grown caterpillars of Brown-Tail Moth; enlarged 1½ times.

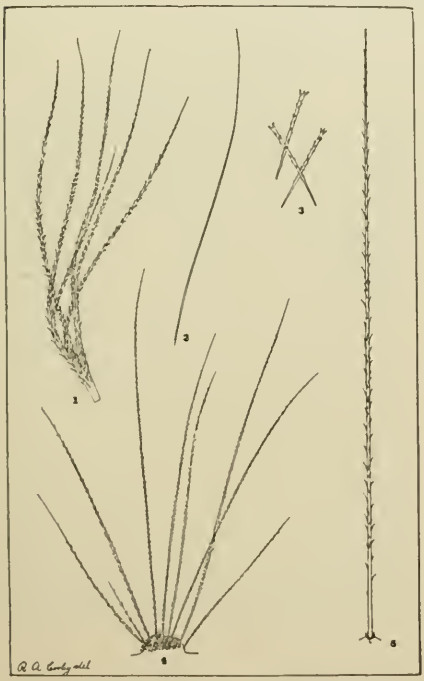


FIG. 22.—Various forms of hairs from Brown-Tail Moth caterpillar. (After Fernald and Kirkland.)

characteristic of it. The third molt occurs during the last week of May (May 28–30, 1905), this usually being the last molt before pupation, but sometimes, as described by Fernald and Kirkland, a fourth molt occurs, thus making five stages of the caterpillar in the spring. The caterpillars are now usually full grown (Fig. 21), and from an inch

FIG. 23.—Several Brown-Tail Moth cocoons on leaves.

to an inch and a quarter long. The head is pale brown, mottled with darker brown. The body is dark brown or black, well marked with patches of orange and covered with numerous tubercles bearing long barbed hairs. The tubercles along the back and sides of the abdomen are thickly covered with short brown hairs in addition to the longer ones, which give these tubercles a velvety appearance under a lens. It is these short hairs (Fig. 22 at 3) which

are the "nettling hairs." The white dashes along the sides of the abdomen are more prominent and enable the immediate identification of the caterpillar of the brown-tail moth from any other in New England. (See Fig. 21.)

FIG. 24.—Pupæ, 1½ natural size. Male and female.

Pupa.—During the second week in June the caterpillars spin up thin silken cocoons of white silk among the leaves, a number often spinning cocoons together, so as to form a considerable mass of web. The cocoon is so loose in structure that the caterpillar, or pupa, may be readily seen through it. Where abundant, they will make the cocoons (Fig. 22) under fences, beneath clapboards and in similar retreats. In these the caterpillars transform to pupæ about the middle or third week of June (June 15–18, 1905). The pupa, shown in figure 24, is slightly over half an inch long, of a dark brown color, with a conical spine armed with numerous small hooks at its tip. Smooth, yellowish-brown hairs are scattered over the

FIG. 25.—Brown-Tail Moths, natural size. Male above, female below.

abdomen and thorax, but none are on the antennæ, legs or wing-covers. The pupal stage lasts for about twenty days.

The Moth.—Most of the moths emerge during the second week of July (July 6 to 10, 1905, mostly emerging on 7th and 8th.) They usually emerge late in the afternoon and are ready to fly that night. Both sexes are pure white, except the abdomen, which is dark brown. The wings of the males expand about one and one third and those of the females one and one half inches, as shown natural size in figure 25. The tip of the abdomen of the female forms a large tuft or brush of golden or dark brown hairs, to which is due the name of the insect. The moths are strong fliers and are readily attracted by lights.

FIG. 26.—Eggs of Brown-Tail Moth on leaf. (After Kirkland.) Reduced.

Eggs.—Egg-laying commences at once. The eggs (Fig. 26) are usually deposited on the under sides of the outer leaves of the tree, toward the tips of the limbs. An egg mass is about two thirds of an inch long by one fourth of an inch wide, contains from two to four hundred eggs, and is covered with dark brown hair from the tip of the abdomen of the female. The egg mass is elongate and is decidedly convex or ridged.

The eggs hatch in about three weeks, about the first of August. (Those at laboratory hatched July 31 to August 4, 1905. Were observed hatching at Rochester August 10, when almost all had hatched.) The young caterpillars feed upon the surfaces of the leaves, skeletonizing them, and when abundant causing the foliage to turn brown, as if

FIG. 27.—Leaves eaten by young caterpillars which have just emerged from egg mass at left, showing characteristic injury in fall.

blighted or scorched by fire (Fig. 27). At first they feed upon the leaf which bears the egg mass, but soon wander to others, returning at night to the original leaf. The little caterpillars are but a twelfth of an inch long when they first emerge, but in about five days they molt for the first time, after which they are about one fifth of an inch long. A week or so later a second molt occurs, though often this is within the winter web during the fall. Early in September the young caterpillars instinctively commence to weave the nest or web, their winter home. It is made of the leaves upon which they have been feeding, usually including the old egg mass at the tip of the twig. The form and shape of the web varies with the position and the materials available. Exit holes are left open so that the caterpillars may go in and out as long as the weather is propitious, but are usually closed during the winter.

MEANS OF DISTRIBUTION.

The principal spread takes place through the flight of the moths just after emergence. "These insects fly freely and have a habit of soaring upward above the tree tops and buildings. When the moths in their nocturnal flights have thus risen in the air, they are often drifted by the wind over long distances." (Fernald and Kirkland.) Thus the strong winds of mid-July, 1897, are known to have carried the moths far northward from the point of origin in Massachusetts and similar winds were undoubtedly responsible for the unusual spread northward and eastward in 1904.

It should be noted in this connection that as the moths are strongly attracted by lights they usually swarm around the electric lights in the center of a town and are always found first in towns and cities, which become centers from which the surrounding country becomes infested. This is a fortunate feature of their spread, for being thus naturally concentrated it is much easier to control the pest on the few town trees than if scattered over the country.

Due to this attraction by lights, the moths have often been spread by electric and railway cars, and possibly steamers, but particularly electrics, the moths flying into the cars and being carried some distance. It has been noticeable in a newly infested territory that the infestation runs along the electric car lines in advance of the main

spread. Like those of the gipsy moth, the young caterpillars have the habit of dropping down from the trees by spinning a strand of silk by which they are suspended, so that they may be picked up by any passing vehicle or may crawl upon it and thus be carried. Undoubtedly this often occurs, but as the spread takes place so much more rapidly by the flight of the moths, it is of minor importance.

FOOD PLANTS AND INJURY.

The pear is the preferred food plant of the caterpillars and is usually first infested where available; the apple comes next and, owing to its abundance, is the tree upon which the webs are first most commonly found in a newly infested section. All of the fruit trees and of the shade trees, elm, oak and maple, are freely attacked, in fact, almost all fruit, shade and forest trees, except the pines, spruces and other conifers are attacked in a badly infested district. Injury to woodlands and forests does not seem to be as serious as that inflicted by the gipsy moth, though often the defoliation is sufficient to cause large tracts to appear brown and seared. As yet, woodlands have not been infested sufficiently for a time long enough to definitely determine just how serious the constant total or partial defoliation by the brown-tail caterpillars will be. It is well known, however, that any deciduous tree wholly defoliated for three or four years is usually killed, and that the wood growth is seriously checked by partial defoliation, so that there is a distinct loss in the timber value.

As the pest concentrates in towns, the shade and fruit trees suffer most and, unless the winter webs are removed, being defoliated year after year, become weakened and soon die. As when defoliated by cankerworms, tent-caterpillars or other caterpillars, fruit trees stripped of their foliage can hardly yield a crop of fruit and the control of the pest upon them is therefore imperative.

DANGER TO HEALTH.

One of the most serious effects of the presence of the brown-tail moth in a community is that of the peculiar skin disease it may produce. Some of the hairs of the full-grown caterpillars are furnished with minute barbs. When the caterpillars molt these barbed hairs are shed with the skin and as the skins become dry and are blown about by

the wind the hairs may be quite generally disseminated. When the hairs alight upon the human skin they cause an irritation, which upon rubbing may develop into inflammation. In New Hampshire this phase of the insect's presence has already become evident. At Portsmouth a clothes-reel was near a tree infested by the caterpillars. The family were greatly troubled through the summer by extraordinary irritations of the skin, for which they were unable to account, but which were doubtless due to caterpillar hairs blown from the pear tree to the clothes upon the reel. In the same city a gentleman, in removing a caterpillar which had landed upon his neck, scattered some of the hairs, which produced an eruption similar to but considerably worse than that produced by poison ivy.

In Massachusetts, where the infestation has been longer known, this danger has become very generally recognized. The following experiences recorded in the report on the brown-tail moth, by Messrs. Fernald and Kirkland, are simply examples of many others which have been reported to the authorities:

A lady in Somerville wrote: "We were shockingly poisoned by the caterpillars of the brown-tail moth. They troubled us all summer. Every member of my family was poisoned. At first we did not know what they were. My little boy could not go near the insects without getting poisoned,—every time he went to pick cherries he would come down from the tree badly poisoned. If my baby went near where they were, his face would break out into a rash. I was so dreadfully poisoned that I thought I had some frightful disease. My hands, face and arms were broken out with this rash. Most of the caterpillars came from a neighbor's place. They came over the fence into the house and even into the closets. They would get on the clothes hung on the line, and when these were worn they poisoned us."

A Somerville physician wrote: "The first we saw of these moths was in 1897. The first cases of poisoning I saw were on Spring Hill Road and Park Street. I saw a number of cases and they were all about the same, except that they varied in point of severity. Some of the cases were very obstinate, and did not respond well to treatment. The same symptoms developed in nearly all cases. The trouble began with an intense irritation, then an eruption appeared, resembling eczema, with a sort of watery blister on the top. There was intense irritation all over the body, on the head, arms and limbs. I saw numbers and numbers

of cases of this poisoning; I should say nearly a hundred cases in all came under my observation. The irritation seemed to remain and was much worse than that caused by poison oak or poison ivy, and was not so easily gotten rid of. I treated most cases with some cooling application. Some cases were decidedly obstinate, but no case was serious enough to menace the life of the patient."

Nettling may be produced, as we have learned from experience, by the younger stages, even those in the webs, where they are freely handled by one with a tender skin. No inconvenience would occur to anyone, however, from handling the unopened webs, and rarely will the young caterpillars be annoying.

The cause of the nettling has been recently investigated by E. E. Tyzzer, A. M., M. D., Assistant in Pathology, Harvard University, and Director of Research, Caroline Brewer Croft Cancer Commission, who has reported on the "Pathology of the Brown-tail Moth Dermatitis." His conclusions are as follows:*

"The most important facts thus far ascertained concerning the brown-tail moth dermatitis may be summarized as follows:

The lesions are produced by the penetration into the epidermis of peculiarly modified microscopic hairs, the nettling hairs, which are sharply pointed and barbed for their entire length. The other hairs of both the caterpillar and moth do not produce any dermatitis.

These nettling hairs develop on the caterpillar, but are also found, as the result of direct transference, on the cocoons, moths, egg masses and in the winter webs, and are blown about in the air. They develop on the subdorsal tubercles of the fifth and sixth segments of the young caterpillars, but are much more numerous as the caterpillars attain their growth, being then found on the subdorsal and the lateral tubercles from the fifth to twelfth segments inclusive. The caterpillars are then very poisonous.

The nettling hairs, which from their shape are perfectly adapted for penetration, possess in addition an irritating substance which is, undoubtedly, an important factor in the production of the dermatitis.

This substance may be destroyed by heating the nettling hairs at 115 C. either in a fluid or with dry heat, or it may be extracted from them with certain solvents, such as dilute solutions of alkalies at room temperature, or water heated to 60 C. Nettling hairs inactivated by either of these measures produce no more than a slight redness when rubbed into the skin, and probably act then merely as foreign bodies.

An index for the presence of the irritating substance is found in a peculiar reaction which takes place when the active nettling hairs are mingled with a drop of blood between a slide and coverglass. This reaction begins about the point of the hair, but spreads rapidly so that a large area is involved. The first change is the breaking up of the rouleaux of red blood corpuscles. The corpuscles then become coarsely crenated; later are spherical, with slender spines protruding from the surface; and finally appear perfectly spherical and closely packed. If the irritating substance has been previously either inactivated by heat or extracted from the nettling hairs, they no longer give this reaction with the red blood corpuscles.

"The dermatitis produced by the nettling hairs is of two types, dependent upon the number of these elements penetrating a given area. The severe type is usually due to actual contact with the caterpillars; the milder scattered rash is due to nettling hairs blown in the air and lodging on the skin or on the under garments as they hang drying. The pathological process in the skin consists of necrosis of the epidermal cells around the nettling hairs, the

* Second Annual Report of the Superintendent for Suppressing the Gipsy and Brown-tail Moths, Massachusetts, January, 1907, pages 154-168.

formation of spaces or microscopic vesicles in the epidermis at the site of injury, and in inflammatory changes about the vessels of the corium.

"Mice inoculated with active nettling hairs present lesions characterized by a large amount of fluid exudate, while those inoculated with inactivated nettling hairs show inflammation of the nature of a reaction due to the mechanical injury brought about by these elements." He appends a bibliography.

Mr. A. H. Kirkland, Superintendent for Suppressing the Gipsy and Brown-tail Moths, in Massachusetts, recommends the following as the best remedy for the brown-tail moth dermatitis: Carbolic acid ½ dram, zinc oxide ½ ounce, lime water 8 ounces; shake thoroughly and rub well into the affected parts. Mr. Kirkland states that in the experience of his men in the parasitic laboratory where they are handling thousands of the caterpillars, this proves the most effective remedy.

FIG. 28.—Pimpla fly on a cocoon of tent caterpillar. One of the native parasites of the Brown-Tail Moth. Twice natural size. (After Weed.)

FIG. 29.—A predaceous bug (*Brachymena 4-pustulata*), such as feed upon the Brown-Tail caterpillars, seen from below, and showing the long, sharp beak between the legs, upon which the caterpillars are impaled.

NATURAL ENEMIES.

A number of parasitic insects which commonly live upon our native caterpillars attack the larvæ and have been bred from the pupæ (Fig. 28) of the brown-tail moth. Predaceous bugs (Fig. 29) also appear in numbers on infested trees and devour large numbers. Toads and bats eat the moths as they fly to electric lights. The worst enemy of the moths, however, is the English sparrow, which attacks them eagerly and consumes large numbers, as well as killing many not eaten. All of the common birds which feed upon our native hairy caterpillars feed upon those of the brown-

tail, particularly the Baltimore oriole, cuckoos and yellow-throated vireo. When the moths commence to emerge they join with the sparrows in the slaughter and between them large numbers are destroyed. But as yet the native enemies have not shown ability to materially check the increase of the pest.

It is well known that in Europe the insect seems to be largely controlled by its natural enemies, so that serious outbreaks occur but once in a number of years in any one locality, in the same manner as do outbreaks of our native insects, such as the forest tent caterpillar or white-marked tussock moth, which are controlled by native parasites.

Many of the parasites and predaceous insects being imported for the gipsy moth also affect the brown-tail moth and others peculiar to it are being imported in large numbers. See pages 121, 122.

REMEDIES.

Destruction of the Winter Webs.—Of all the means for controlling the brown-tail moth, the destruction of the winter webs or nests is by far the most important, the most practical, economical and efficient. The webs are conspicuous on the tips of the limbs from October to April and usually may be readily removed by pole shears or long-handled pruners. All webs should be collected and burned in a stove, as they do not burn readily, and if burned in an open fire out of doors some may be merely scorched, and if the nests be allowed to lie on the ground or in a brush heap the young caterpillars will emerge in spring and usually find plenty of food. When the snow is on the ground the nests may be more readily found where they drop. On large trees with numerous nests it is well to have one man below the tree to point out the nests to two or three men doing the pruning, thus saving time and ensuring thorough work. Long ladders and climbing irons will occasionally be necessary for high trees and will be found useful by those making a business of collecting the webs. All webs should be removed by April 1.

The question is often asked, "Will it pay me to clean the webs from my own trees if my neighbor does not?" A glance at figure 31 will answer this better than argument. From the habits of the pest it is apparent that but little spread takes place except by the winged moths in late summer. If the caterpillars are so abundant as to spread from neighboring property they may be prevented by sticky bands on the uninfested trees as described below.

Fig. 30.—Upper view, neglected pear orchard, Winchester, Mass., stripped by Brown-Tail Moth caterpillars, June, 1905; lower view, same orchard, properly cared for, 1906. (After Kirkland.)

The efficiency of their destruction was well shown in the City of Somersworth during the past summer. The city and private property owners had done most excellent work the previous winter in destroying the webs, but in one or two cases the ignorance or obduracy of the property owner prevented the destruction of the webs by the city employés. In one small yard with scarcely a dozen fruit trees where the webs were not destroyed the caterpillars appeared in such numbers that every apple tree was

Fig. 31.—Pear tree defoliated by the caterpillars of the Brown-Tail Moth. The webs on the trees in the background were destroyed the previous winter. Photograph taken at Vine Street, Somerville, Mass., May 27, 1897. (After Fernald and Kirkland.)

absolutely defoliated and were gathered by the peck at the bases of the trees. Thorough spraying of the trees with arsenicals and spraying the caterpillars which had crawled on neighboring fences and houses with pure kerosene, destroyed most of them. But the expense was ten fold what it would have been to have pruned off the webs in winter, and enough caterpillars escaped destruction to reinfest the whole community. In another case a limb of a large apple tree (Fig. 32, *a*) overhung a neighbor's yard in such a way that it was difficult to remove the nests with-

FIG. 32.—Apple tree defoliated by Brown-Tail Moth caterpillars at Somersworth, N. H. June, 1906. From the main part of one tree, *b*, the webs, were removed the previous winter, but were not removed from the limb *a* overhanging the next yard, which was therefore defoliated, while the rest of the tree remained practically unharmed. The other tree, *c*, was not pruned of webs and was also defoliated.

out entering the adjoining property. Permission to do so was refused. As a result this branch and another tree (Fig. 32, *c*) on the untreated property was defoliated, while the rest of the tree (Fig. 32, *b*), from which the nests had been removed, bore its normal foliage unmolested.

Spraying.—While the caterpillars are young they may be effectively destroyed by spraying with arsenate of lead. The brown-tail caterpillars seem to be much more susceptible to the poison than those of the gipsy moth. Experiments made by us in the laboratory indicate that if sprayed while the caterpillars are young early in May arsenate of lead at the rate of three pounds per barrel of water should be sufficient, but if delayed until late in May or June 1, when they are nearly full grown, five pounds per barrel should be used.

When the eggs hatch in early August and the young caterpillars skeletonize the leaves prior to forming their winter webs (see figure 27), they may be readily killed by spraying with arsenate of lead or Paris Green. In the apple orchard there are numerous other caterpillars doing more or less damage to the foliage at this season which may be controlled by the same spraying, which therefore becomes a practice to be commended. Experiments made by us show that not less than five pounds of arsenate of lead to a barrel of water should be used, and that an increase to ten pounds per barrel merely results in killing the caterpillars a day or two quicker. Arsenate of lead is preferred on account of its unusual adhesive properties, remaining on the foliage several weeks after hard rains. Paris Green is very much quicker in its effect and is, therefore, to be preferred in some respects when there is no immediate prospect of rain. Care must be taken in the use of Paris Green that plenty of lime be added to prevent burning of the foliage, while arsenate of lead may be used in large quantities without danger in this regard. Our experiments indicate that a half pound of Paris Green per barrel will kill the caterpillars as quickly as ten pounds of arsenate of lead, but it does not follow, therefore, that Paris Green is to be preferred, as the other factors above mentioned must be considered.

Experiments made during the past season show that by thorough spraying early in August the trees were practically freed of the winter nests, while other trees in the same orchard were well covered with them. Furthermore, besides controlling the brown-tail moth, a number of com-

mon apple caterpillars such as the fall webworm, the red-humped apple caterpillar, yellow-necked apple caterpillar and others which appear early in August as well as a large part of the second brood of the codling moth may be controlled by spraying at this time. Although this spraying may not entirely clear an orchard of the pest, the winter nests will be so reduced that it will take but a little time to prune them and the reduction in the cost of pruning will more than pay for the spraying. Spraying at this season will not injure or poison the fruit.

Spraying or sprinkling with kerosene emulsion or strong

FIG. 33.—Newly hatched Brown-Tail Moth caterpillars feeding on upper surface of apple leaf—enlarged.

soap solution will often destroy the caterpillars when they swarm on fences and walks.

Banding.—Uninfested trees may often be protected by applying a band of some sticky substance over which the caterpillars are unable to cross. This will *not* be effective (1) if the branches of the trees interlock with those of an infested tree; (2) if the trees stand so close together that the small caterpillars can pass from one to the other while suspended on their fine threads; (3) if the band either hardens or becomes covered with dust so that it does not remain sticky; and (4) if the caterpillars are allowed to become so numerous beneath the band that they form a bridge over it with their threads and dead bodies. The bands should therefore be frequently inspected and the

caterpillars below them removed or destroyed. If not destroyed they will often leave the trees for shrubbery, where it is more difficult to cope with them, and will transform to moths. "Insect lime, raupenleim, tanglefoot, bodlime, printer's ink, or even axle grease are among the materials

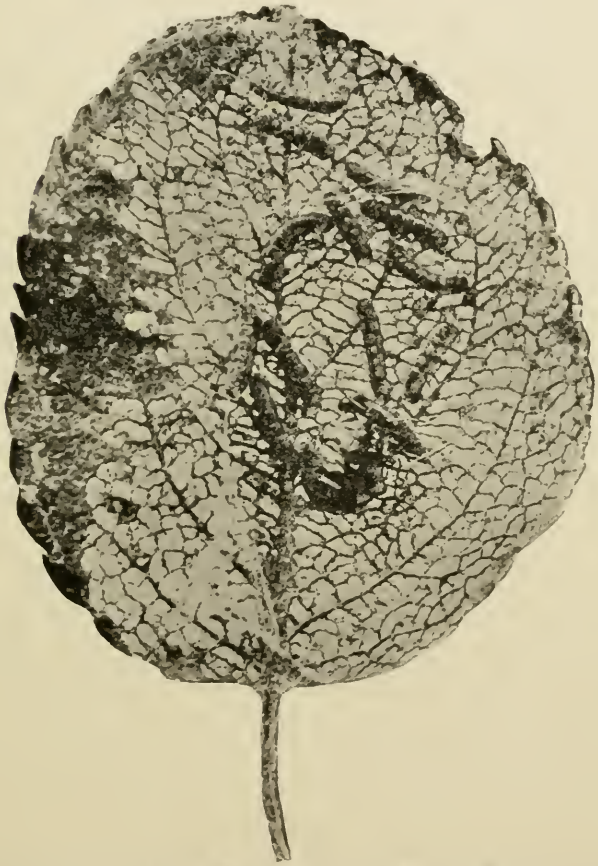


FIG. 34.—Young Brown-Tail Moth caterpillars which have skeletonized an apple leaf in early September. Greatly enlarged.

more used for banding. All may be dangerous to the tree and should be removed after the caterpillar season has passed." (Kirkland.) Possibly the most satisfactory and safest substance is printer's ink applied as a band on heavy building paper, beneath which is placed a band of cotton

next to the bark of the tree to prevent the ink from injuring the tree and the ascent of the caterpillars in the crevices of the bark beneath the paper.

This banding will not, however, prevent reinfestation by the winged moths, which fly to them and deposit their egg clusters in July, so that it is not as efficient as in the case of the gipsy moth, which does not spread by flight, and which makes apparent the necessity of destroying the insect in its immature stages as far as possible, so that the winged moths may not spread, if its numbers are to be reduced from year to year.

Destroying Pupæ.—Late in June and early July the cocoons containing the pupæ may be gathered, though it is likely to be attended with severe inflammation of the skin from the nettling hairs if precautions are not taken. Such cocoons or pupæ should be placed in a barrel or box covered with mosquito screening so that the moths are confined but any parasites which develop may escape through the screen.

Destroying the Moths.—Often the electric light and telegraph poles near lights are covered with the white-winged moths, in which case they may be largely destroyed by washing down with a stiff jet of water from the hydrant hose. A spray of pure kerosene or kerosene emulsion may also be found desirable under some circumstances for destroying the moths.

NECESSITY OF THE CONTROL OF THE BROWN-TAIL MOTH.

In the southeastern corner of the state, where the brown-tail moth has now become abundant, everyone is impressed with the importance of doing everything possible to suppress or control it, as are those persons who have been unfortunate enough to have visited in the infested district in Massachusetts during the caterpillar season. In general the New Hampshire public seems alive to the necessity of the control of the pest.

Under the law passed in 1907 it now becomes incumbent on every property owner to remove and destroy the winter nests on his trees up to a cost of one-half of one per cent of the taxable valuation of the property. It is incumbent on the selectmen of towns and mayors of cities to see that this is done or to have the work done at the expense of the town and city and charge same to the taxes of the negligent property owner. If the selectmen or mayors fail in their duty, they may be compelled to act by the governor and council. The law seems ample to ensure that everyone

do their fair share of the work to control this pest along the highways and around dwellings. It is not, of course, contemplated that there will be any attempt to clear woodlands of the pest, except possibly public parks and pleasure grounds. The control of the pest will be accomplished by a civic pride, which will prevent it being allowed to defoliate the shade trees and become a menace to the public health.

The complete law is appended to this bulletin, and should be carefully studied by all property owners and particularly by selectmen and those officials having its enforcement in charge.

Fight the Moth Pests.

Let every citizen who loves and is proud of the grand old shade trees which line the highways of New Hampshire; let every farmer and fruit grower who wishes to prevent a future heavy tax in combatting these pests in his orchards; let every lover of the mountains and forests of the Granite State insist upon immediate action by the towns in which it is now necessary, and the increase of State and Congressional appropriations for the suppression of these pests, which have already caused such serious devastation, and which if not controlled in the immediate future, may bring about injury beyond prediction.

BIBLIOGRAPHY.

Further accounts of these pests will be found in the following publications.

Britton, W. E., The Gipsy and Brown-Tail Moth. Bulletin 153, Conn. Agr. Exp. Station.
Sixth Report of the State Entomologist, Part IV, Report Conn. Agr. Experiment Station (1906), pp. 235-260.

Felt, E. P., The Gipsy and Brown-Tail Moths, Bulletin 103, New York State Museum. (1906). 15 cents.

Fernald and Kirkland, The Brown-Tail Moth. Pages 73, plates 14. Mass. State Board of Agr. (1903). Out of Print.

Forbush and Fernald, The Gipsy Moth, pp. 495, plates 66. Mass. State Board of Agriculture (1896). Out of print.

Hitchings, E. F., The Gipsy Moth in Maine, Bulletin of the Dept. of Agriculture (Me.), Vol. VI, No. 1. (1907).
The Brown-Tail Moth in Maine, Bulletin of the Dept. of Agriculture (Me.), Vol. IV, No. 4. (1905).
First and Second Annual Reports of the Maine State Entomologist. (1906, 1907). Augusta, Maine.

Howard, L. O. Bulletin 11, n. s., Division of Entomology, U. S. Department of Agriculture.
Farmers' Bulletin, 264, U. S. Dept. Agr. The Brown-Tail Moth and How to Control It. (1906).
Farmers' Bulletin 275, U. S. Dept. Agr. The Gipsy Moth and How to Control It. (1907).

Kirkland, A. H., Bulletins 1 and 2, and 1st and 2d Annual Reports of the Superintendent for Suppressing the Gipsy and Brown-Tail Moths, Massachusetts. Boston.

Stene, A. E., Report of the (Rhode Island) Commissioner for the Suppression of the Gipsy and Brown-Tail Moths. (1906).

(Chapter 147.)

AN ACT TO PROVIDE FOR SUPPRESSING THE GIPSY AND BROWN-TAIL MOTHS.

Be it enacted by the Senate and House of Representatives in General Court convened:

Eggs, etc., public nuisances; landowners not liable.

Section 1. For the purposes of this act, the eggs, caterpillars, pupae and nests of the gipsy and brown-tail moths, and said moths are hereby declared public nuisances; but no owner or occupant of an estate infested by such nuisance shall by reason thereof be liable to an action, civil or criminal, except to the extent and in the manner and form herein set forth.

State agent for suppression; compensation and duties.

Sect. 2. The governor, with the advice of the council, shall employ, when and as they see fit, a state agent to act in suppressing said moths, said agent to have such official designation, to receive such compensation, and to be employed for such time as the governor and council may determine. Said agent shall in all particulars, including the employment of assistants and the disbursements of necessary expenses, be subject to the direction and control of the governor and council, who may establish such rules and regulations pertaining to said matters, and may enter into such arrangements for coöperating in said work with persons, corporations, municipalities, states or governments, as they shall deem expedient.

Cities and towns to coöperate; to be reimbursed by state, when.

Sect. 3. Cities, by such public officer or board as may be designated or appointed by the board of mayor and aldermen, and towns, by their boards of selectmen, shall destroy or cause to be destroyed said moths and the eggs, caterpillars, pupae, and nests thereof within their limits, except in parks and other property under the control of the state and in private property, save as otherwise provided herein. When any city or town shall have expended in any one calendar year, within its limits, its funds to an amount equal to one tenth of one per cent. of its tax valuation of the previous year in destroying or suppressing said moths in any of their stages as herein provided, it shall receive reimbursement from the state to the extent of fifty per cent. of any expense in excess of said one tenth of one per cent. No city or town shall be entitled to reimbursement from the state as aforesaid until it shall have submitted to the state treasurer its itemized receipted accounts and vouchers showing the amounts expended by it for the purpose specified in this section nor until

said vouchers and accounts have been approved by the governor and council. Vouchers so presented and approved shall be paid by the state treasurer out of any appropriation made for the purposes of this act. All pay-rolls, schedules of bills, or other records of expense under this section shall be submitted monthly in such form as said state treasurer shall prescribe and shall be duly attested by the treasurer of the city or town.

Compulsory action by towns, when; procedure if town fails to act.

SECT. 4. The governor and council, through their agent aforesaid or directly, may order any city or town which, in their opinion, neglects or refuses to comply with the provisions of the preceding section, to proceed in accordance with methods prescribed by them, to destroy said moths in their various stages, provided that the expense of the prescribed methods, together with such other sums as such city or town may have otherwise expended in such work during the same fiscal year, shall not exceed one tenth of one per cent. of the tax valuation of said city or town for the preceding year. If any city or town shall fail to comply with such orders, the governor and council, through their agent or other employees, may cause the work so ordered to be done; and in such case, the expense thereof, not exceeding said one tenth of one per cent. of the tax valuation aforesaid, less any sums spent by said city or town in complying with the provisions of this act, may be recovered of said city or town in an action of debt brought in behalf of the state by the attorney-general; and in addition thereto, any city or town failing to comply with the directions of the governor and council in the performance of said work, shall forfeit the sum of one hundred dollars for its failure so to do, the same to be collected by information brought in the name of the attorney-general in the county in which said city or town be located.

Owner of infested premises to be notified; procedure if owner fails to act.

SECT. 5. The public officer or board designated or appointed in cities as provided in section 3 and the board of selectmen in towns, on or before the first day of November in each year, and at such other times as he or they may deem necessary, or as the governor and council may order, may and, if so directed by order of the governor and council, shall, cause a written or printed notice to be delivered or mailed to the owner or owners, so far as can be ascertained, of any parcel of land therein which is infested with gipsy or brown-tail moths, requiring that said moths and the eggs, caterpillars, pupae, and nests thereof upon said land shall be destroyed within a reasonable time, to be fixed by said officer or board and specified in said notice. If such owner or owners shall be unknown or non-resident in said city or town, said notice shall be given to the occupant, if any, of said land, otherwise it shall be posted upon the land. Whenever, in the opinion of said officer or board, the cost of destroying such moths, eggs, caterpillars, pupae, and nests on lands contiguous and held under one ownership in the city or town, will exceed one half of one per cent of the assessed valuation of said lands, including buildings and improvements thereon, as fixed by the last preceding tax appraisal, then a part of said premises upon which the cost of such destruction will not, in the opinion of said officer or board, exceed said percentage of the assessed valuation of the whole, shall be designated in said notice as the tract on which said moths, eggs, caterpillars, pupae or nests shall be destroyed, and such requirement shall not apply to the remainder of said premises.

Said notice may designate the manner in which said work shall be done, which shall be subject at all times to the approval of the governor and council or their agent. If the owner or owners of said lands shall fail to destroy such moths, eggs, caterpillars, pupae or nests, or to cause them to be destroyed, in accordance with the requirements of said notice, then the city acting by the public officer or board designated or appointed, as provided in section 3, and the town, acting by its board of selectmen, may and, if so ordered by the governor and council, shall destroy the same, and the amount actually expended thereon, not exceeding one half of one per cent. of the assessed valuation of said land as heretofore specified in this section, shall be assessed upon said lands and improvements, and the amount required in addition thereto shall be apportioned between the city or town and the state in accordance with the provisions of section 3 of this act. The amounts to be assessed upon private estates as herein provided shall be assessed and collected like ordinary taxes at the next general tax assessment following their expenditure, and shall be a lien on said estates in the same manner and with the same effect as is provided in the case of other taxes, and shall be subject to the provisions of sections 10 and 11 of chapter 59 of the Public Statutes, relative to abatement and appeal.

Proceedings to enjoin nuisance.

SECT. 6. The attorney-general may commence and prosecute proceedings for an injunction to restrain the continuance of any nuisance specified in this act whenever in his opinion such action is required for the protection of the public against the effects of such nuisance.

State and national agents may enter premises.

SECT. 7. It shall be lawful for any agent or employee of the state or of the United States to enter upon any land in this state for the purpose of searching for or destroying said moths in any of their states, and to employ all proper and reasonable methods to destroy the same, doing no unnecessary damage to the premises.

Expenditure of funds by governor and council.

SECT. 8. The governor and council, independently of or in cooperation with landowners and cities and towns, may expend or cause to be expended such sums as they may deem proper in destroying said moths in any of their stages, without regard to the amounts which may have been expended by such landowner, or such city or town, in any locality where in their opinion conditions require special efforts in suppressing or destroying said pests.

Appropriations not exceeding $25,000.

SECT. 9. To meet the expenses incurred under the authority of this act, the governor and council are authorized and empowered to expend such sums, not exceeding the total sum of twenty-five thousand dollars, as they may deem proper; and the governor is authorized to draw his warrant for said sums, payable out of any funds not otherwise appropriated.

Wilful obstruction of state or national agents, etc.; penalty.

SECT. 10. Any person who wilfully resists or obstructs any state agent or his assistants or any officer or agent of the United States or of a city or town while lawfully engaged in the execution of the purposes of this act, and any person who wilfully brings into this state, disseminates or propagates any gipsy or brown-tail moth eggs, caterpillar or pupae, shall be deemed guilty of misdemeanor and shall be fined not exceeding one hundred dollars for each offense.

Takes effect on passage.

SECT. 11. This act shall take effect upon its passage.

(Approved April 5, 1907.)

639.73 N53 4
New Hampshire
639.73
N53
4